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SOIL MANAGEMENT PRACTICES
IN THE
UPPER PEACE RIVER REGION

by

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Newly-broken Gray Wooded soil showing a typically light-colored surface.

CANADA DEPARTMENT OF AGRICULTURE
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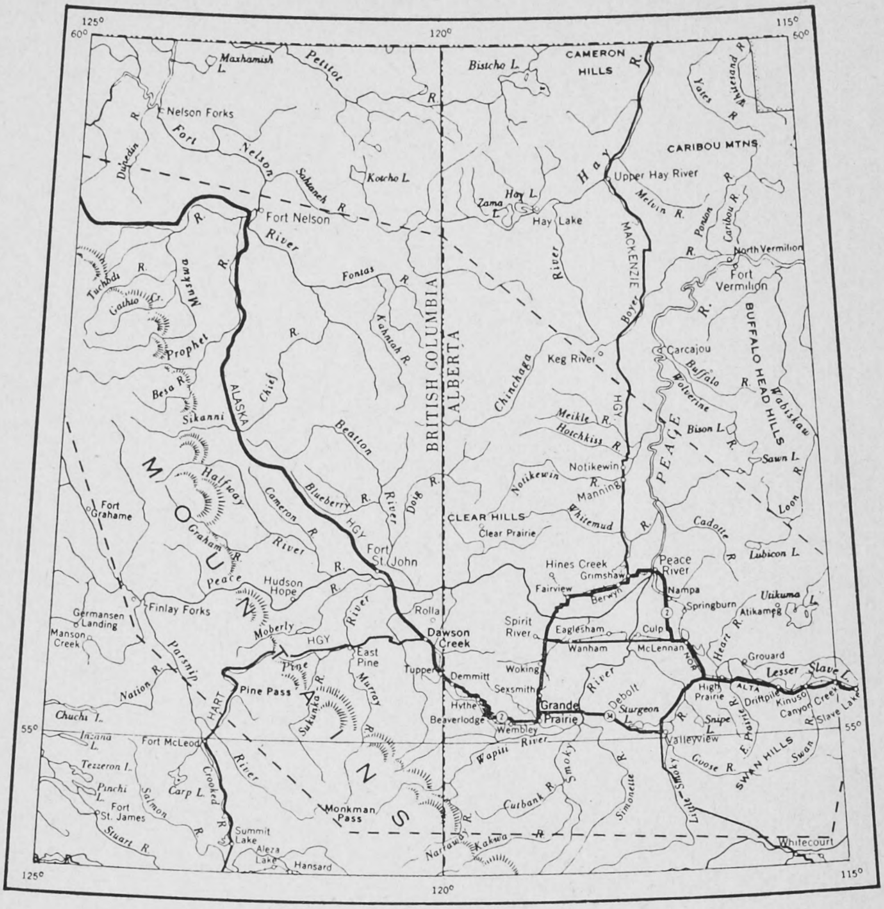

PEACE RIVER REGION

ALBERTA and BRITISH COLUMBIA

SCALE

Miles 25 0 25 50 Miles

Fig. 1.—Map of the Peace River Region of Alberta and British Columbia with area served by the Beaverlodge Experimental Farm contained within broken lines.

CONTENTS

FOREWORD

Growth conditions in the Peace River region vary widely with respect to soil, topography and exposure but generally are favorable for sustained productivity if basic principles are observed. Five suggestions are offered:

1. Include grasses and legumes in the cropping system on all soil types.
2. Select tillage implements carefully keeping in mind the work to be done, the effect upon soil structure and the cost.
3. Consider timeliness of cultivation operations, their effect upon soil structure and the effect upon following crops.
4. Combine the use of commercial fertilizers with a sound cropping program. Pay attention to the correct formula and rate of application for the crop being grown.
5. Use deep-rooted legumes for soils having a tough and compacted subsoil.

SOIL MANAGEMENT PRACTICES IN THE UPPER PEACE RIVER REGION

C. H. Anderson[1] and E. C. Stacey[2]

INTRODUCTION

Settlement of the Peace River region commenced shortly after the turn of the century and by 1911 the population was 8,800, including settlers, traders, missionaries and Indians. By 1921 the population had reached 25,000. The present population is approximately 100,000. About 2,000,000 acres are under cultivation.

It is estimated that over 80 per cent of the potentially arable land of the region is Gray Wooded, hence future settlement will be principally on these soils. A sound understanding of their usage is essential if agriculture in the area is to flourish. The policy of the Experimental Farm at Beaverlodge is to keep farmers informed of approved methods of soil management and to continue the search for better farm practices.

As might be expected, the highly productive Degraded Black and Black soils of the region were settled first, the pioneers choosing the more open prairie locations. Grain farming with emphasis on wheat was adopted. As settlement continued, Gray Wooded soils were brought under cultivation. Production on these soils was at first disappointing but with a change in farm practices, involving the use of grasses and legumes, good crops were obtained.

CLIMATE

The mean summer temperature of the upper Peace River region is generally slightly cooler than that of other agricultural areas of northwestern Canada. However, because of the higher latitude, the longer days compensate for the effect of lower temperatures on crop growth, at least for cool weather crops such as cereals. Since 1930 the average frost-free period at the Beaverlodge Experimental Farm has been 100 days, ranging from less than 90 days in four years to greater than 110 days in 15 years. It is possibly more significant that the number of crop days, those with minimum temperatures above 28°F., averages 132, with fluctuations since 1930 ranging from 107 to 172 days.

In a northerly region with undulating terrain, temperatures can vary markedly between locations. Minimum temperature readings taken on the Experimental Farm from 1930 to 1942 in a slough at a point ½-mile distant and 134 feet below the elevation of the meteorological site averaged 6·9 degrees lower than the official record. Extremes were as great as 26 degrees in winter and 19 degrees in summer, indicating incipient frost at any time at the lower level. This was borne out by crop production; medium-early-maturing varieties of wheat were comparatively safe on the hillside while oats and barley were the only crops that could be ripened in the slough area. This specific location may represent a somewhat extreme variation from the mean but the factors which cause it are operative generally, so that the choice of crops and cropping procedures should be determined to some extent by location within the locality.

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Precipitation readings of 17.43 inches annually suggest ample moisture for at least moderate crop growth, especially as free-water evaporation totals slightly less than 18 inches. However, only 7·9 inches of rain falls in the period May-August inclusive. The June precipitation of 1·96 inches is barely ample for satisfactory crop growth and lesser amounts restrict yields of most field crops. Autumn precipitation is not heavy, but, together with a favorable amount of snow melt, it usually provides adequate moisture reserves for germination.

TABLE 1.—METEOROLOGICAL RECORDS, 1946-55 INCLUSIVE
EXPERIMENTAL FARM, BEAVERLODGE, ALBERTA

Month	Temperature in °F			Precipitation in inches			Bright sun in hours	Wind hourly velocity in m.p.h.	Evaporation in inches
	High-est	Low-est	Mean	Rain	Snow	Total precip-itation			
Jan.	44.8	−53.1	3.55	0.01	15.25	1.54	69.4	7.0	....
Feb.	60.7	−43.8	11.16	0.01	14.20	1.43	106.9	6.9	....
Mar.	60.6	−35.3	20.06	0.03	8.71	0.90	153.4	7.2	....
April	71.0	−31.3	34.20	0.32	5.88	0.91	199.8	9.4	0.45
May	83.2	17.7	49.76	1.59	0.28	1.62	271.1	9.5	3.07
June	89.1	32.1	56.10	1.53	....	1.53	275.2	9.0	3.55
July	90.1	34.9	59.38	3.42	....	3.42	279.5	7.6	3.62
Aug.	88.4	27.1	56.36	1.95	0.51	2.00	245.9	6.9	2.74
Sept.	86.0	15.9	50.28	1.21	1.27	1.33	197.1	7.7	2.06
Oct.	78.5	− 8.4	39.53	0.54	3.90	0.93	144.9	7.9	0.87
Nov.	71.3	−26.6	23.15	0.12	7.09	0.83	80.8	6.6	....
Dec.	53.6	−35.9	11.05	0.05	11.87	1.24	64.1	6.6	....
Annual	....	....	34.55	10.78	68.96	17.68	2088.1	7.7	16.36
Long-term	....	....	*35.59	*10.55	*68.94	*17.43	X2032.7	†8.0	x17.85

* 1916-55 (40 years)
X 1923-55 (33 years)
† 1936-55 (20 years)
x 1922-55 (34 years)

SOILS

The soils of the region are mostly Gray Wooded, with various Degraded Black and Black soils occurring in association with them. It is estimated that the region contains 16,500,000 acres of arable land of which 13,000,000 acres are Gray Wooded soils and 3,500,000 acres Degraded Black or Black soils. The Degraded Black soils differ from the Gray Wooded soils in that they have been developed in areas where woodland vegetation has been less dense or not permanently established. Hence the breakdown due to degradation is not so great as in their Gray Wooded counterparts.

Soils having tough, dense subsoils are found in areas of Gray Wooded, Degraded Black and Black soils and are represented by the soil series listed in Table 4. There are varying degrees of dense soils; the term solonetz indicating the tougher form. A solod, on the other hand, is one which has passed through this tough, dense state leaving it with a leached, platy structured top and a more permeable subsoil.

TABLE 2.—PRECIPITATION RECORDS AT THE EXPERIMENTAL FARM, BEAVERLODGE, ALBERTA

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total annual snowfall	Total annual rainfall	Total annual precipitation
1946	1.62	0.90	0.18	0.11	1.37	1.54	1.31	0.89	1.57	0.35	0.99	1.97	58.10	6.99	12.80
1947	2.55	2.40	0.67	1.18	1.49	1.27	5.57	2.21	1.33	0.91	0.83	1.65	87.71	13.29	22.06
1948	0.64	2.54	1.54	2.28	0.84	0.83	3.88	3.99	1.62	0.45	0.46	0.88	78.70	12.08	19.95
1949	1.56	1.39	0.86	0.82	1.74	2.15	1.84	2.14	0.93	0.94	0.91	2.12	65.10	10.89	17.40
1950	0.44	1.19	0.19	0.96	2.20	0.55	2.42	2.21	0.91	0.65	2.20	0.91	63.85	8.44	14.83
1951	1.26	2.33	1.44	1.09	2.07	1.10	8.23	1.86	1.22	2.27	0.53	0.87	72.70	17.00	24.27
1952	2.03	0.93	0.84	0.36	0.41	2.01	2.18	2.36	1.03	0.52	0.15	0.40	47.10	8.51	13.22
1953	3.43	0.42	0.99	0.80	2.02	2.63	2.13	0.74	1.30	0.40	0.94	0.80	71.10	9.49	16.60
1954	1.13	1.84	1.19	0.77	1.97	2.48	1.36	3.43	2.10	0.92	0.27	1.14	72.00	11.40	18.60
1955	0.71	0.38	1.12	0.73	2.11	0.77	5.31	0.17	1.32	1.85	1.02	1.66	73.20	9.83	17.15
40-year average	1.36	1.04	1.11	0.83	1.57	1.96	2.53	1.85	1.68	1.11	1.20	1.19	68.94	10.55	17.43

Extremes for the 40-year period 1916–55

Low	0.05	0.00	0.18	0.03	0.21	0.38	0.41	0.17	0.21	0.18	0.00	0.13	28.50	4.70	9.76
Year	1942	1923 1931	1946	1921	1916	1922	1917	1955	1917	1923	1943	1943	1923	1922	1923
High	3.85	2.63	2.12	3.05	6.62	2.63	8.23	4.60	4.89	3.22	3.43	3.35	114.30	17.60	24.27
Year	1920	1939	1920	1938	1917	1953	1951	1924	1929	1939	1933	1933	1925	1941	1951

NOTE: Snow is converted to rain (10 inches of snow equals 1 inch of rain).
Meteorological records taken in co-operation with the Meteorological Division of the Department of Transport.

TABLE 3.—OCCURRENCE OF FROST AND FROST-FREE PERIODS, EXPERIMENTAL FARM, BEAVERLODGE, ALBERTA

Frost: 32°F or lower; Killing frost: 28°F or lower

Year	Last frost in spring		First frost in fall		Number of frost-free days	Last killing frost in spring		First killing frost in fall		Number of crop days above 28°F
	Date	Temp. °F	Date	Temp. °F		Date	Temp. °F	Date	Temp. °F	
1946	May 14	30.9	Sept. 6	31.2	115	May 9	26.8	Sept. 7	27.1	121
1947	May 18	30.9	Aug. 19	30.8	93	May 5	25.9	Sept. 17	27.2	135
1948	May 3	29.9	Aug. 26	28.2	115	Apr. 28	27.8	Sept. 29	27.2	154
1949	May 26	31.9	Sept. 10	31.6	107	May 23	27.4	Sept. 11	20.7	111
1950	May 24	31.3	Aug. 15	31.9	83	Apr. 26	27.1	Aug. 16	27.1	112
1951	May 30	27.0	Sept. 14	32.0	107	May 30	27.0	Sept. 23	25.0	116
1952	May 7	28.9	Aug. 15	31.8	100	May 6	23.9	Oct. 3	24.0	150
1953	May 11	32.0	Sept. 20	29.4	132	Apr. 30	26.8	Oct. 2	27.8	155
1954	May 7	31.3	Sept. 17	29.3	133	May 2	25.0	Sept. 20	27.8	141
1955	May 28	29.8	Sept. 9	30.1	104	May 14	26.7	Sept. 10	23.4	119
40-year average	May 26	....	Sept. 3	....	100	May 10	....	Sept. 19	....	132
Shortest crop season: 1918	June 5	30.0	July 23	29.0	48	June 1	25.0	Aug. 10	27.0	70
Longest crop season: 1944	May 12	28.9	Sept. 29	27.3	140	Apr. 16	25.8	Oct. 5	25.6	172

Earliest and latest frost dates (32°F or lower, 1916–55)
Latest spring frost June 18, 1922; 32°F; 1932: 30°F
Earliest last spring frost, May 3, 1948: 29.9°F
Earliest fall frost, July 23, 1918: 29°F
Latest first fall frost, October 6, 1938: 30.8°F

Earliest and latest killing frost dates (28°F or lower, 1916–55)
Latest spring killing frost, June 8, 1935; 28°F
Earliest last killing frost of spring, Apr. 16, 1940: 25.8°F
Earliest fall killing frost, Aug. 10, 1916: 27°F
Latest first killing frost of fall, Oct. 16, 1938: 26.9°F

TABLE 4.—SOME REPRESENTATIVE SOILS OF THE PEACE RIVER REGION HAVING DENSE SUBSOILS*

Soil series	Profile type	Acres
Donnelly	Gray Wooded, solodized solonetz	276,000
Esher	Degraded Black, solod to solodized solonetz	123,000
Falher	Degraded Black, solodized solonetz	222,000
Kavanaugh	Degraded Black to Black, solonetz	9,200
Valleyview	Degraded Black to Black, solodized solonetz to solonetz	2,000
Landry	Black, solodized solonetz	29,000
Nampa	Gray Wooded, solodized solonetz	75,000
Rycroft	Black, solodized solonetz	52,000
		788,200

* Wm. Odynsky, and J. D. Newton. Report Nos. 15 and 63, Alberta Soil Survey, 1950 and 1952.

In total acreage, Table 4 is misleading since these data cover only the areas for which survey reports are available. It is estimated that for the entire area this figure might reach 2,000,000 acres or more. These fine-textured soils do not absorb moisture readily and may be seriously eroded by heavy rains. They are difficult to work and hinder root penetration. A further characteristic is the acid nature of the topsoil.

All soils of the area are not fine textured. Many are composed of sandy and silty materials and are not so well supplied with gypsum. These soils are generally slightly acidic and range from very fertile to poor agricultural soils.

There are a number of difficult management problems associated with Gray Wooded soils. Wind and water erosion may be overcome to some extent by increasing the fiber content of the surface soil. Water erosion may be decreased by opening up the subsoil to allow for ready penetration of moisture. Most of these soils have a low reserve of available mineral plant foods. Many of them puddle following wetting with the result that the surface forms a crust which hinders plant emergence.

The Degraded Black and Black soils were better supplied with plant nutrients in their native state but continuous cropping has depleted plant nutrients, fiber and organic matter to the point where they require fertilizers and careful cropping to restore their productivity.

Large areas of peaty soils occur throughout the region in association with other soils. They are found in low, poorly drained areas and are composed of sedge peat or moss peat. Locally these soils are all referred to as "muskeg". Generally the sedge peats are more fertile than the moss peat soils and are easier to bring under cultivation.

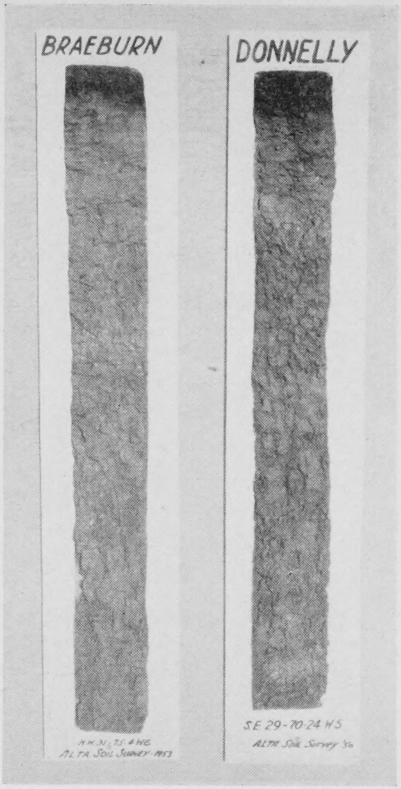

Fig. 2.—Profiles of Gray Wooded soils typical of the region.

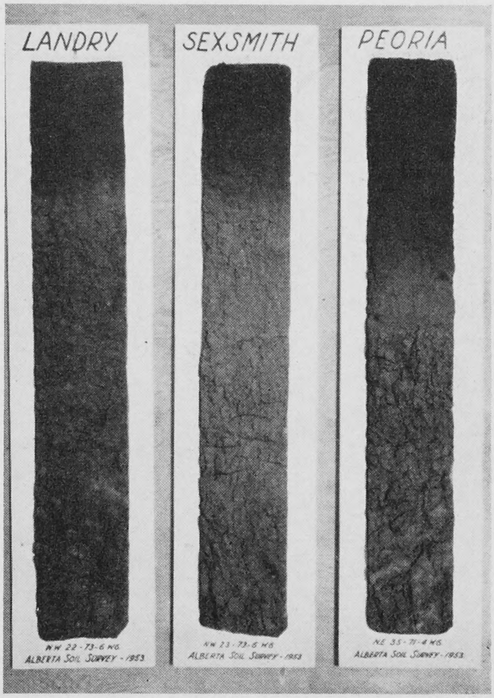

Fig. 3.—Profiles of Black soils typical of the region.

SOIL MANAGEMENT

It was originally believed that Gray Wooded soils were inferior to the Black soils because of the many problems which confronted those who attempted to farm them. A better understanding now exists and with proper management these soils can be expected to produce satisfactorily. For example, Gray Wooded soil (Nampa series) has produced up to 60 bushels of wheat and nearly 100 bushels of oats per acre when careful attention was paid to land preparation and legumes were used to condition the soil. On the other hand, Black soil (Belloy series) has been known to produce low yields of grain in dry seasons when certain Gray Wooded soils produced satisfactory crops. At Beaverlodge, Black soil under cultivation for 45 years has yielded 11·9 bushels of wheat per acre on fallow for the years 1951-54. Where 11-48-0 was applied at 50 pounds per acre the average yield for the same period has been 25·0 bushels.

Gray Wooded soils differ from the Degraded Black and Black soils in structure and fertility but the same principles of management apply. In deciding how to handle them it must be remembered that the Gray Wooded soils are naturally low in fiber and organic matter, hence have poor physical condition and retarded microbial activity. The Degraded Black and Black soils are generally better supplied with organic matter in their native state and although their initial fertility is generally higher they too must be farmed wisely if production is to be maintained.

One third of the farm acreage should be devoted to forage crops in order to maintain soil fertility. Grasses and legumes included in the rotation add fiber and organic matter. Legume roots penetrate compacted soils making it possible for following crops to utilize plant nutrients stored in the subsoil.

Wherever possible crop residue should be saved and worked into the soil. The preservation of residue on the surface is particularly important where soil drifting or water erosion is a problem. The use of straw cutters on combines has simplified the handling of heavy straw cover.

The selection of cultivation equipment is important. Pulverizing implements such as the oneway disk and disk harrow should be used with caution on these soils because of the ease with which structure is broken down. This breakdown may be minimized by operating machinery at recommended speeds.

Packing is important to conserve moisture and to ensure even germination.

Farm manures supply nutrients, increase bacterial action and favorably modify the surface soil so that moisture penetration is enhanced. Commercial fertilizers are beneficial when applied according to recommendations based upon soil type, previous cropping history, and the crop to be grown.

Sod-producing crops should be broken early and where possible summerfallowed a full season to allow for adequate decomposition of the sod. This holds particularly true for the grasses because of the large amount of fiber involved.

The Gray Wooded soils require careful management early in their cultivated life. In this respect they differ from the Black soils, which generally produce satisfactorily for several seasons after breaking. The use of legumes is of particular importance to the successful management of the Gray Wooded soils. Grasses can only be grown successfully on these soils in combination with legumes or when fertilized.

Many of the Gray Wooded soils puddle readily. If this occurs it will be advantageous to harrow immediately to break the crust. This is particularly important in the spring when heavy rains follow seeding. If left undisturbed the surface soil may become sealed, thus seriously impeding emergence of germinating plants. It is suggested that seeding rates might be increased slightly on these soils.

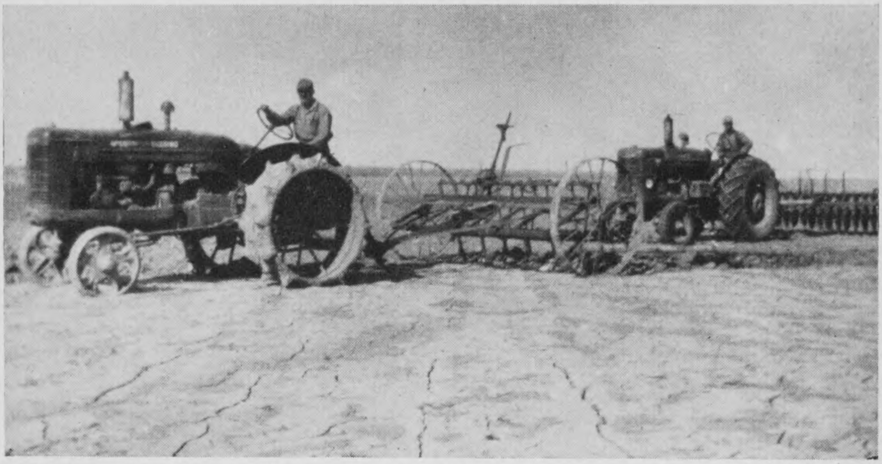

Fig. 4.—Surface crusting of a Gray Wooded soil low in organic matter.

Fig. 5.—Sheet erosion on Degraded Black to Black soil low in organic matter.

Information on the management of peat soils is limited but farmers are bringing such soil under cultivation with varying degrees of success. A few suggestions are offered. Only the shallow peat soils, i.e., up to 18 inches of organic accumulation, should be considered for annual cropping. The deeper peat or bog soils are not adapted to cereal production because of excessive moisture and because of the frost hazard in areas where poorly drained soils exist. These latter soils are better adapted to hay and pasture

production but barnyard manure or commercial fertilizers are required if production is to be maintained. It has been demonstrated that such soils can be utilized for the growing of sweet clover, creeping red fescue, brome grass or combinations of these grasses with moisture-loving legumes such as alsike and red clover.

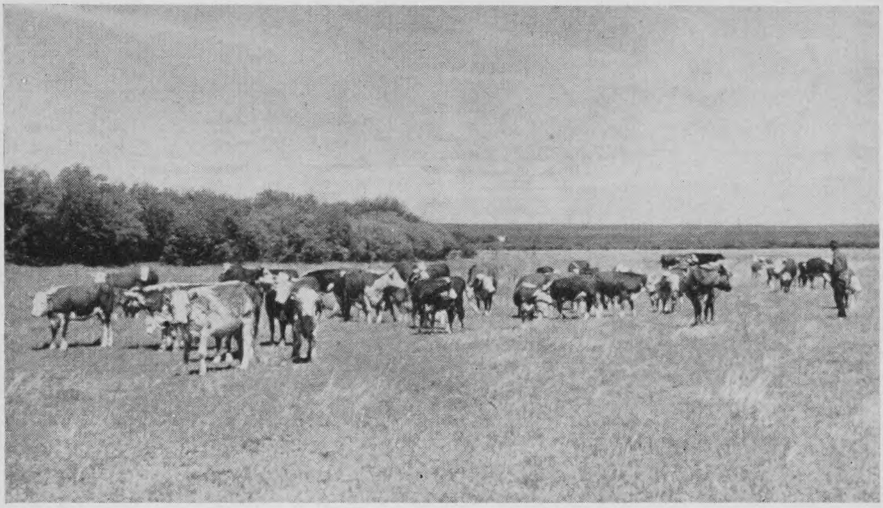

Fig. 6.—Livestock are important in a soil improvement program.

The packing associated with pasturing will firm the surface and hasten decomposition. Over a period of years it may be possible in this way to prepare the land for future grain cropping.

Burning is not recommended because it destroys organic matter.

Fig. 7.—Sweet clover that was oneway disked into the soil to improve fertility.

EROSION CONTROL

Most soils of the region are susceptible to wind and water erosion. Those characterized by a heavy and impermeable subsoil do not absorb moisture readily, hence when flash rains occur the excessive run-off carries away precious topsoil. Sheet and gully erosion are common in many areas on what appears to be level land. The high salt content in the lower horizon of some soils produces a friable subsoil which erodes readily when a heavy flow of water is directed into inadequate road ditches.

A soil conservation program calls for extensive use of forage crops. The legumes, particularly the deep-rooted sweet clover and alfalfa, assist in opening up tough and impermeable subsoil. This increases permeability and moisture-holding capacity and reduces the danger of water erosion. Grasses add fiber which binds the soil particles together, thus serving to decrease erosion by wind and water.

Creeping red fescue is an ideal grass for erosion control because its dense turf effectively slows run-off and prevents the cutting action of swiftly moving water, particularly where ditches are sloped to take care of heavy runoff.

Fig. 8.—Severe erosion in roadside ditch resulting from heavy runoff.

Water erosion on a hillside on the Beaverlodge Experimental Farm has been significantly decreased by strip cropping on the approximate contour. The fields are parallel, at approximately right angles to the slope and include grass-legume strips at convenient intervals to reduce water velocity. Each field is subjected to a sequence of fallow-wheat-barley repeated four times, after which the strip remains in a grass-legume mixture for four years The rotation is worked systematically across the slope. Erosion has been reduced considerably and yields have been maintained at a satisfactory level. This

system of cropping serves to make a higher percentage of sloping land suitable for grain cropping. It is imperative that farm fields be run across rather than with the slope.

Wind erosion can also constitute a serious problem where fiber has been depleted; even in their native state many soils are low in fiber and subject to erosion by wind. Where wind erosion is a problem, fields should be arranged at right angles to the prevailing winds to reduce the width of the exposed summerfallow surface. Grass or grass-legume strips should be alternated with the summerfallow and cropped strips.

Fig. 9.—Strip cropping to reduce water erosion on sloping land.

CROPPING FOR SOIL IMPROVEMENT

In their natural state Degraded Black and Black soils are more fertile than Gray Wooded soils. Accordingly, farmers who settled on the more productive soils were slower to adopt rotations including grasses and legumes. It is now recognized that all soils of the region require good husbandry if production is to be maintained and that none of the soils of the region is adapted to continuous grain farming.

Fortunately vigorous stands of forage crops can be secured with comparative ease. Grasses can be used to maintain adequate amounts of soil fiber, while legumes fix atmospheric nitrogen and increase microbiological activity in the soil, thereby serving to maintain fertility.

Deep-Rooted Legumes

Though subject to experimental confirmation, it is suggested that good crops of cereals follow sweet clover and alfalfa because the penetrating taproots improve aeration, increase moisture-holding capacity and utilize phosphates which have been leached into the subsoil, and upon decay, release this plant food for the use of subsequent crops.

Being a biennial, sweet clover is adapted to short-term rotations. It grows well on the Gray Wooded soils and can usually be depended upon to serve as a substitute for summerfallow. The beneficial residual effect of sweet clover on some of the less fertile Gray Wooded soils has been evident for as long as three years following the plowing of sweet clover stubble.

In an experiment in which sweet clover was employed in a four-year rotation on Gray Wooded soil at three widely separated points in the region, the yield of wheat following sweet clover was increased five bushels per acre, or 21 per cent, as compared with wheat following oats in the same series.

Alfalfa has all of the good qualities of sweet clover but does not develop its root system so rapidly. Also, since alfalfa is essentially adapted to long-term rotations there is a possibility that moisture reserves may be depleted during seasons of continued drought. Alfalfa thrives on all well-drained soils but cannot be depended upon as a seed crop. In mixture with brome grass and creeping red fescue it is excellent for hay and for pasture. A year of fallow is advisable following the growing of alfalfa to ensure eradication and to restore moisture reserves.

TABLE 5.—EFFECT OF CLOVER VERSUS SUMMERFALLOW ON GRAY WOODED SOIL (NINE-CROP AVERAGE)

Rotation	Yield in bushels or tons per acre			
	First crop wheat	Second crop wheat	Third crop oat hay	Sweet clover hay
	bu.	bu.	tons	tons
Oats seeded to sweet clover, sweet clover, wheat, wheat. (sweet clover stubble plowed)..........	21.4	18.3	1.69	0.80
Oats, fallow, wheat, wheat..........................	19.5	18.6	1.66	....

TABLE 6.—YIELDS OF CROPS FROM FOUR TREATMENTS IN THREE ROTATIONS ON BLACK SOIL, BEAVERLODGE, ALBERTA, 1949-54

Rotation	Crop	Treatment per acre			
		Nil	11-48-0 @ 35 lb.	Manure 10 tons	Manure 10 tons plus 11-48-0 @ 35 lb.
		bu.	bu.	bu.	bu.
Continuous...............	Wheat..................	20.0	26.2	30.8	34.6
Wheat-wheat-fallow.......	Wheat after fallow.......	26.6	34.6	36.1	39.2
	Wheat after wheat*......	21.3	24.6	31.2	32.5
Wheat-wheat-sw. clover...	Wheat after sw. clover^x..	25.3	33.1	38.4	36.9
	Wheat after wheat.......	21.6	27.6	28.4	31.6
	Sw. clover after wheat*..	0.64	0.68	0.72	0.77

NOTE:—Manure is applied in fallow year of fallow-wheat-wheat rotation and to the sweet clover stubble prior to plowing in the wheat-wheat-sweet clover rotation, i.e. every third year.
* Five-year average.
x Four-year average.

Shallow-Rooted Legumes

Alsike grows satisfactorily where moisture is adequate, thus it is a valuable crop for low-lying areas or where moisture is held in heavy-textured soils. On the more fertile Black soils alsike produces heavy vegetative growth but this does not necessarily indicate a satisfactory seed crop as pollination depends on adequate bee populations.

Red clover is better adapted to the Black soils than is alsike and is also grown with considerable success on the Gray Wooded soils. It requires moderate moisture and being a relatively shallow-rooted legume, replenishes the surface soil with nitrogen without depleting moisture reserves.

Grasses

Creeping red fescue and brome grass are the principal species adapted to the region. They thrive on the Degraded Black and Black soils and may be counted upon to restore large amounts of fiber and organic matter. Creeping red fescue is particularly valuable for soils low in organic matter because of the dense mat of fiber produced. Its use as a pasture and seed crop has done much to promote grassland farming in the Peace River region.

Timothy and crested wheat grass can also be grown, but they are not so well adapted nor so important with respect to maintenance of fertility as brome grass and creeping red fescue.

Grasses such as Russian wild rye, Merion blue grass and others now under study may have a place in future programs.

Grasses generally do not perform satisfactorily on the Gray Wooded soils as their adaptibility depends largely upon available nitrogen in the soil. Where they can be established and grown it has been noted that additional nitrogen is usually required for continued production. This requirement may be achieved by sowing the grasses in combination with legumes.

Crop Rotations

The Degraded Black and Black soils are generally referred to as the better soils of the area but they are not always the most productive. Because of their original fertility they have often been abused and have in some cases been seriously depleted. Farmers on these soils have been slow to adopt rotations including grasses and legumes.

Summerfallow should be practised only where necessary for moisture accumulation prior to seeding down or when breaking up a meadow sod to allow for adequate decomposition before cropping to grain. It may also be necessary for the control of some persistent perennial weeds.

The basic rotation for a balanced farming enterprise including livestock consists of: Fallow, grain (seeded to brome grass, alfalfa and creeping red fescue), hay, hay, hay, pasture and break in June, grain, grain.

The following rotation is suggested for immediate improvement of Gray Wooded soils: Grain (seeded to sweet clover), sweet clover, grain, grain.

For low, moist clay areas a sequence of fallow, grain (seeded), alsike (three years), grain, grain, grain, is suggested for seed production.

For opening up compacted soils a rotation of grain (seeded), sweet clover, grain, may be followed.

For limited livestock and where emphasis is on seed production use a cropping system of: Fallow, grain (seeded to sweet clover and brome grass), sweet clover for hay or seed, brome grass seed, brome grass seed, pasture and break in June, grain, grain. Creeping red fescue could be used in place of the brome grass if desirable. It is highly desirable to break the grass early to allow for adequate cultivation and rotting of the turned sod.

If grass seed production is practised, the following cropping sequence can be adapted to suit the needs of most areas: Fallow, grain (seeded), creeping red fescue, fescue seed, fescue seed, pasture and break, grain, grain. Brome grass and other recommended grasses may be substituted for creeping red fescue.

These rotations may be altered to suit different conditions and other grasses and legumes may be substituted.

Preparing Grassland for Grain Cropping

Grasses grown without legumes require a full season of summerfallow following breaking to allow for decomposition of the sod before cropping to grain. This applies on all soil types. To obtain a good kill of grass break late in the fall, preferably just before freeze-up, and leave unworked. In this way roots are exposed to the killing action of frost and the summerfallow operations complete the eradication process. If it is desired to rejuvenate the grass, breaking should be done in the early autumn and the sod worked down immediately. If this is done the grass will usually be established the following year and a cash grain crop can be obtained, the yields depending upon the moisture supply.

Various implements may be used for turning the sod. Where a dense turf exists the plow has been found most suitable.

FERTILIZER REQUIREMENTS

The use of commercial fertilizers in the Peace River region has resulted in substantial increases in production of farm crops, despite dry weather in some seasons. Regardless of soil type, phosphorus has been beneficial for grain crops; there is also evidence that added nitrogen is beneficial. Hay and pasture crops have shown a marked response to nitrogen fertilizers, as have grass crops grown for seed. Grain crops grown on partially decomposed grass sod or when seeded into heavy combine straw or stubble have also benefited from applications of nitrogen fertilizers.

Commercial fertilizers are not to be considered as corrective measures in themselves but should be used in conjunction with a sound rotation program as indicated in Table 6.

In appraising fertilizer response it should be kept in mind that less than five bushels per acre difference may not be distinguished by sight; furthermore, the better the crop the more difficult it will be to detect a difference between fertilized and unfertilized grains. It is easier to distinguish between a 15- and a 20-bushel per acre crop than between a 50- and a 55-bushel per acre crop.

When purchasing commercial fertilizers it is well to know what the various formulae stand for. The figures in the formula indicate the percentage of nitrogen, phosphate and potash in that order; a fertilizer labelled 11-48-0 contains 11 per cent nitrogen (N), 48 per cent phosphate (P_2O_5) and contains no potash. If labelled 33-0-0 the fertilizer contains 33 per cent nitrogen (N) and contains neither phosphate or potash.

Fig. 10.—Fertilized wheat on fallow, Beaverlodge, Alberta. The two rows at left of the rule received nitrogen alone, whereas the two rows at the right received nitrogen and phosphorus.

Cereals

Extensive tests conducted throughout the region on a number of different soils have shown that increases in yield of 3 to 10 bushels per acre of wheat can be expected from an application of ammonium phosphate 11-48-0. Maturity of the crop will also be advanced from 3 to 10 days under average conditions. Oats and barley respond even more markedly to ammonium phosphate than does wheat. Yield data collected for Gray Wooded and Degraded Black and Black soils are recorded in Table 7.

Ammonium phosphate 11-48-0 at 25 to 50 pounds per acre is recommended for wheat, oats and barley grown on summerfallow and on light stubble where moisture is adequate.

When the above grains are seeded on grassland broken out of sod and sufficient time has not been allowed for satisfactory decomposition, a nitrogenous fertilizer such as ammonium nitrate (33-0-0) at 100 pounds per acre is required. Ammonium sulphate is also satisfactory but is not required in the Peace River region for its sulphur content. If the sod has been well decomposed or the land has been summerfallowed for a full season before cropping it is suggested that 16-20-0 be applied at 40 to 60 pounds per acre. Results of tests conducted on grassland broken out of sod are reported in Table 8.

If seeding is made into a heavy combine straw and stubble it is suggested that 16-20-0 be applied at 40 to 60 pounds per acre. Heavier applications of nitrogen may be required depending upon the amount of straw to be decomposed.

For flax grown on fallow and light stubble 11-48-0 is recommended at 25 pounds per acre. Where flax is grown on grassland broken out of sod the recommendations for cereals will apply.

TABLE 7.—YIELDS WITH AND WITHOUT FERTILIZER TREATMENTS TO WHEAT, OATS AND BARLEY, PEACE RIVER REGION, 1951–54

Fertilizer		Degraded Black and Black soils						Gray Wooded Soils					
		Grain after fallow			Grain after stubble			Grain after fallow			Grain after stubble		
Treatment	lb. per acre	Wheat basis 21 crops	Oats basis 11 crops	Barley basis 13 crops	Wheat basis 17 crops	Oats basis 11 crops	Barley basis 14 crops	Wheat basis 19 crops	Oats basis 12 crops	Barley basis 13 crops	Wheat basis 13 crops	Oats basis 12 crops	Barley basis 12 crops
Check	Nil	31.7	48.1	39.3	24.3	44.3	31.3	30.2	60.9	42.4	17.2	35.4	30.4
Increase over unfertilized check:													
11–48–0	25	9.3	22.3	15.4	5.5	10.3	8.4	4.4	11.9	11.8	3.1	10.0	3.4
"	50	13.4	26.2	19.7	6.6	11.8	10.2	7.9	11.9	16.1	6.1	14.2	7.8
16–20–0	30	6.1	16.0	11.3	3.5	8.9	6.7	3.1	9.4	9.8	2.5	9.3	5.1
"	60	8.2	19.2	14.7	6.1	14.0	11.5	6.3	10.7	10.2	5.3	13.4	7.4
"	120	11.4	25.7	20.0	7.9	20.4	16.7	9.1	19.8	18.3	7.9	20.6	12.4
33–0–0	29	0.1	−1.6	−2.6	1.7	1.4	2.8	0.5	2.4	3.4	2.5	5.6	2.2
"	58	0.0	−6.7	−2.9	2.4	4.9	3.7	1.3	2.4	1.9	4.4	9.0	5.4

TABLE 8.—YIELDS OF GRAIN FOLLOWING BREAKING OF GRASS SOD, 1952–54

Fertilizer		Wheat on spring broken fescue sod in bu. per acre	Wheat on autumn one-wayed fescue sod in bu. per acre	Flax on autumn broken brome grass sod in bu. per acre	Flax on autumn broken fescue sod in bu. per acre
Treatment	lb. per acre				
Check	Nil	4.4	9.2	9.2	6.8
Increase over check:					
33–0–0	25	...	3.6	...	2.0
"	50	...	6.7	...	3.6
"	75	...	...	...	3.6
"	100	11.6	...	7.0	...
11–48–0	25	...	1.3	...	1.5
"	50	...	3.3	...	1.2
16–20–0	30	...	3.0	...	...
"	60	...	5.2	...	...
"	120	...	7.8	...	...

Hay and Pasture

Results of a pasture research project conducted at Brainard, Alberta, have shown that depleted Gray Wooded soils will support satisfactory cultivated pastures. It is presumed that the results will also apply on the Black soils of the region. With creeping red fescue and fescue-alfalfa pasture, annual applications of 100 pounds per acre of ammonium nitrate have increased yields and carrying capacity. With brome grass-alfalfa pasture, nitrogen-phosphorus fertilizer has been most beneficial. The results obtained to date are presented in Table 9.

Fertilizing of hay crops on the Experimental Farm in recent years has indicated that medium applications of nitrogen fertilizers are beneficial, particularly where the stand has been established for a number of years. This is particularly true if a grass constitutes the bulk of the forage mixture.

TABLE 9.—PRODUCTION FROM THREE DIFFERENT PASTURES EACH WITH THREE DIFFERENT FERTILIZER TREATMENTS ON GRAY WOODED SOIL, 1953–54

Pasture	Fertilizer treatment	Forage yield in pounds dry matter per acre	Pounds of lamb produced per acre	Animal unit pasture days per acre
Creeping red fescue	Unfertilized	1,541	76	39
	33–0–0 @100 lb/acre	3,158	138	61
	11–48–0 @300 lb/acre	3,046	131	62
Fescue plus alfalfa	Unfertilized	3,408	174	72
	33–0–0 @100 lb/acre	4,770	210	87
	11–48–0 @300 lb/acre	5,094	215	96
Brome grass plus alfalfa	Unfertilized	3,818	205	68
	33–0–0 @100 lb/acre	3,994	185	72
	11–48–0 @300 lb/acre	5,957	307	95

Grass Seed Production

Experiments conducted throughout the region indicate that seed production of second-, third- and fourth-year crops of creeping red fescue may be markedly increased by the autumn application of 100 pounds per acre of ammonium nitrate. On soils of known nitrogen deficiency the first crop has also benefited from nitrogen application. Seed yields have been doubled with fall applications. Early spring applications have likewise been beneficial but generally autumn applications have been superior. Farmers throughout the region have reported responses to nitrogen fertilizers which parallel experimental results. Brome grass seed production has also been stimulated somewhat by applications of nitrogen fertilizer.

TABLE 10.—SEED YIELDS OF CREEPING RED FESCUE AND BROME GRASS UNDER DIFFERENT FERTILIZER APPLICATIONS, 1952*

Fertilizer		Yield of spring fertilized creeping red fescue in lb./acre	Yield of autumn fertilized creeping red fescue in lb./acre	Yield of spring fertilized brome grass in lb./acre
Treatment	lb. per acre			
Unfertilized check yields....	....	215	197	57
Increase over check				
16–20–0....................	250	241	287	56
33–0–0.....................	66	123	136	47
"	132	189	235	113
21–0–0.....................	195	242	195	52

* The experiments reported were conducted on Degraded Black soil. The creeping red fescue was in its third season of production; the brome grass was fourth crop.

Legume Seed Production

In a limited number of trials conducted on Gray Wooded soils the application of various commercial fertilizers has failed to increase seed yields of alfalfa, sweet clover and alsike. These crops are capable of obtaining their own nitrogen from the air. It is also thought that these crops, particularly the deep-rooted legumes such as sweet clover and alfalfa, are capable of obtaining their phosphorus supplies from the lower soil horizons. Recent pasture research has suggested that the application of a nitrogen-phosphorus fertilizer in the year of seeding may serve to establish a strong stand before the roots are sufficiently established to reach the available plant nutrients stored in the subsoil.

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